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Abstract

A Method for Calculating Collision Probabilities in General Cylindrical Geometry and Applications to Flux Distributions and Dancoff Factors

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The collision probability method for calculating neutron flux distributions is at present acquiring increasing attention particularly for its application to comparatively small strongly heterogeneous systems, for example reactor lattice cells. This method can be applied to systems with rather complicated geometry. Due to the fact that it ignores the angular flux distribution and concentrates on the interesting quantity, the scalar flux, it can in many cases give a considerable saving in computer time compared to various other methods for numerically solving the transport equation. An obvious drawback is that this method usually assumes isotropic scattering and regionwise constant flux.

The main feature of the method is the calculation of the collision probabilities. Fundamental equations for cylindrical geometry are presented in this paper, and are applied to cells with annular geometry and to cells containing a central rod cluster. The necessary integrations are performed in a way different from the one commonly used, in order to shorten the numerical work. Particularly for the annular geometry, it is possible to arrange the integration in such a way that an efficient Gauss integration can be performed. The Gauss constants are chosen with regard to the known irregularities of the integrand, with different possible sets of constants being investigated.

Moments of the first flight distance can be calculated in much the same way as the collision probabilities for neutrons originating in each region. This makes it possible to calculate the axial and radial diffusion areas for a given source distribution when the flux distribution has been solved. This theory is also presented in the paper.

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This work has lead to several computer programs, and results from calculations are reported in the paper. Since the problem under investigation is the transport of neutrons, only one energy group problems have been investigated so far. However, there is no objection to the use of these methods in many-group calculations.

Only a white boundary condition has been used throughout the work in this paper at the cell boundary. The collision probability matrix is calculated for a black cell boundary, and the white boundary matrix is obtained by a simple adjustment.

A closely related problem would be the calculation of Dancoff factors. In the case of annular geometry, Dancoff factors can be obtained directly from collision probabilities. Dancoff factors can be obtained in the same way for cluster geometry, but it would be more suitable to use a special computer program. In this paper a theory is presented for the calculation of Dancoff factors in cluster geometry, and tables of results are given for the ordinary 7-, 19-, and 37-rod cluster.